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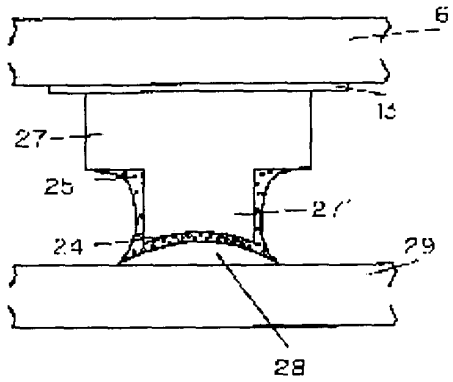
(54) METHOD FOR CAPILLARY AND BUMP FORMING OF WIRE BONDING APPARATUS

(57)Abstract:
PURPOSE: To electrically connect the end of the bump of a semiconductor device to the terminal electrode of a circuit board with high reliability when the device is face-down-mounted on the terminal electrode of the board formed by screen printing, plating, etc., via a junction layer.
CONSTITUTION: A curvature 24 is formed at the end of the bump of a semiconductor device 6, and face-down-mounted at the input and output terminal electrode 28 of a circuit board 29 via a junction layer. Thus, the thickness of the junction layer can be formed thinnest and uniform, and the electric connection and adherence of the low connecting resistance of the connecting part and high reliability can be realized.



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) is the outline cross section of the point of the capillary tube for wirebonding equipments in the 1st example of this invention.
(b) is the detail drawing of the configuration of the point of a capillary tube.
[Drawing 2] Front view of the bump of the letter of a two-step salient of the semiconductor device in the 1st example of this invention
[Drawing 3] Process drawing showing the outline of the method of forming a two-step bump using the capillary tube by this invention
[Drawing 4] ******** showing the semiconductor unit mounted by the electroconductive glue on the circuit board in the semiconductor device which has the two-step bump formed of this invention
[Drawing 5] The schematic diagram of the method of forming a concave-like curve side in a bump's point using a convex type-like fixture in the 2nd example of this invention
[Drawing 6] (a) It is ******** showing a state and the mounted semiconductor unit before pasting up the semiconductor device which has a plating bump [in / the 3rd example of this invention / it reaches and / in (b)] by the electroconductive glue on the circuit board.
[Drawing 7] (a) It is ******** showing a state and the mounted semiconductor unit before pasting up the semiconductor device which has an one-step bump [in / the 4th example of this invention / it reaches and / in (b)] by the electroconductive glue on the circuit board.
[Drawing 8] ******** showing the semiconductor unit which mounted the semiconductor device which has a two-step bump in the 1st and 2 example of this invention by anisotropy electric conduction material on the circuit board
[Drawing 9] ******** showing a different semiconductor unit from drawing 8 which mounted the semiconductor device which has a two-step bump in the 1st and 2 example of this invention by anisotropy electric conduction material on the circuit board
[Drawing 10] (a) is the outline cross section of the point of the capillary tube for the conventional wirebonding equipments.
(b) is the detail drawing of the configuration of the point of the conventional capillary tube.
[Drawing 11] Process drawing showing the outline of the method of forming a two-step bump by the ball bonding method using the conventional capillary tube
[Drawing 12] The outline cross section showing a bump's typical configuration by which leveling was carried out by the conventional ball bonding method
[Drawing 13] (a) is the outline cross section of the solder bump of the conventional semiconductor device.
(b) is the outline cross section of the conventional semiconductor unit.
[Drawing 14] The outline cross section of a semiconductor unit using the conventional electroconductive glue
[Description of Notations]
1 Capillary Tube
2 Wire Derivation -- Hole
3 Lobe
4 Metal Wire
5 Ball
6 IC Chip (Semiconductor Device)
7 Bump
8 Bump's Crowning
9 Bump's Bottom
11 Face of Capillary Tube
12 Edge of Capillary Tube
13 Electrode Pad
15 Soffit Side of Lobe
24 Bump's Point
25 Electroconductive Glue

27 27' Salient electrode (bump)
28 Input/output Terminal Electrode
29 Circuit Board
41 Convex Type Fixture
42 Soffit Side of Lobe of Convex Type Fixture
60 Electrical Installation Contact (Solder Bump)
61 Metal Membrane
63 Electrode Pad
66 IC Chip (Semiconductor Device)
68 Input/output Terminal Electrode
69 Circuit Board
70 Salient Electrode (Bump)
73 Electrode Pad
76 IC Chip (Semiconductor Device)
78 Input/output Terminal Electrode
79 Circuit Board

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CLAIMS

[Claim(s)]
[Claim 1] The capillary tube for the ball bondings for forming a bump on the electrode pad of a semiconductor device characterized by providing the following. the press to which the aforementioned capillary tube presses the point of the shape of a ball of a metal wire to an electrode pad, and the aforementioned ball-like point is made to stick to the aforementioned electrode pad by pressure -- a member the derivation which supplies the aforementioned metal wire prepared in the aforementioned press member -- a hole leveling for establishing the field which curved in the shape of a concave to a bump's point formed on the aforementioned electrode pad -- a member
[Claim 2] It is a capillary tube for the wirebonding equipments according to claim 1 with which the press member includes the soffit side (1st soffit side) of a capillary tube, a leveling member has the 2nd soffit side which presses a bump, and the soffit side of the above 2nd has the convex curve side.
[Claim 3] The bump who is a bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board, and has the field which was formed on the electrode pad of the aforementioned semiconductor device, and which curved in the shape of a concave to the point.
[Claim 4] How to form the bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board using wirebonding equipment characterized by providing the following. The process a which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device. The process b which forms a curve side in the aforementioned bump's point in the shape of a concave at the same time it excises a metal wire.
[Claim 5] Process b is the formation method of the bump who has the curve side according to claim 4 characterized by including the process which levels the aforementioned bump in order to arrange a bump's point configuration.
[Claim 6] A bump is the formation method of the bump who has the curve side according to claim 4 characterized by being formed from the alloy containing Au, Cu, aluminum, solder, or these either.
[Claim 7] Process a is the formation method of the bump who has the curve side according to claim 4 characterized by forming a bump on an electrode pad by the ball bonding method.
[Claim 8] How to form the bump for connecting electrically the terminal electrode of the front face of the circuit board characterized by providing the following, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board. The process which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device. The curve side characterized by the bird clapper from the process formed using the ** implement which has a convex type-like curve side for a concave-like curve side in the aforementioned bump's point.
[Claim 9] A bump is the formation method of the bump who has the curve side according to claim 8 characterized by being formed on an electrode pad by plating, the wirebonding method, etc.
[Claim 10] The circuit board which has a terminal electrode on a front face. The semiconductor device mounted in the state of the face down on the front face of the aforementioned circuit board. It is the semiconductor unit equipped with the above, and the aforementioned semiconductor device is characterized by having a bump for connecting electrically an electrode pad, the aforementioned electrode pad, and the aforementioned terminal electrode, forming a curve side in the aforementioned bump's point, and forming the junction layer between the aforementioned bump's point, and the aforementioned terminal electrode.
[Claim 11] A junction layer is a semiconductor unit according to claim 10 characterized by being formed from an electroconductive glue.
[Claim 12] A junction layer is a semiconductor unit according to claim 10 characterized by being formed from anisotropy electric conduction material.

[Translation done.]

connection being strong of carrying out flip chip mounting in the state of a face down.
[0016] For example, the mounting method which used the solder galvanizing method for the volume Kogyo Chosakai Publishing Co., Ltd., January 15, 1980 issue, and on Japanese microelectronics association and "IC-ized mounting technology" is indicated. This mounting method is explained below.
[0017] Drawing 13 shows the outline cross section (a) of the solder bump of the conventional semiconductor device, and the outline cross section (b) of a semiconductor unit. As shown in drawing 13 , when connecting the electrode pad 113 of a semiconductor device (IC substrate) 116 to the input/output terminal electrode 118 of the circuit board 119 shown in drawing (b), the adhesion metal membrane 112 and the diffusion prevention metal membrane 111 are first formed by the vacuum deposition on the electrode pad 113 of a semiconductor device (IC substrate) 116, and the electrical installation contact (henceforth a solder bump) 110 which consists of solder is further formed with plating on this. Next, as IC chip formed by doing in this way is shown in drawing 13 (b), alignment is performed in the state of a face down so that the solder bump 110 may contact on the input/output terminal electrode 118, and it lays on the circuit board 119. Then, the solder bump 110 is welded to the input/output terminal electrode 118 of the circuit board 119 by heating the mounting object (semiconductor unit) of this semiconductor device to an elevated temperature.
[0018] Moreover, recently, as shown in the outline cross section of the semiconductor unit which used the electroconductive glue of drawing 14 , the electrical installation contact (Au bump) 120 is formed with the wirebonding method or plating on the electrode pad 123 of a semiconductor device (IC substrate) 126, and a semiconductor unit which connects this Au bump 120 to the input/output terminal electrode 128 of the circuit board 129 through an electroconductive glue (junction layer) 125 is also proposed. In such a semiconductor unit, after imprinting an electroconductive glue 125 by the Au bump 120 of a semiconductor device 126, alignment was carried out so that the Au bump 120 might contact the input/output terminal electrode 128 of the circuit board 129, the electroconductive glue 125 was hardened, and electrical installation has been obtained.
[0019]
[Problem(s) to be Solved by the Invention] Above conventional capillary tubes, conventional bumps, and bump formation methods require cost, in order for a semiconductor device to take the process which forms a bump, and the leveling process for operating the bump who formed orthopedically further. Moreover, the equipment for performing leveling is also required separately. However, it is not desirable to skip a leveling process. Since a bump's crowning 88 in which it was formed by the ball bonding method is carrying out the shape of a ring, and the inverted-U character type configuration, and the area of the edge of a crowning 88 is small, its touch area with the terminal electrode of the circuit board is small. Moreover, since the variation in a bump's height is also large, reliable connection cannot be made in having mounted as it is. Furthermore, in the above configurations of the bump before leveling, when using an electroconductive glue for a junction layer, since the bond strength after carrying out electroconductive-glue hardening from there being few amounts of imprints of the electroconductive glue to a bump point, and the variation in the amount of imprints being large is small, connection resistance will also become [the reliability of adhesion] low greatly.
[0020] Since the terminal electrode on the circuit board is formed by screen-stencil or plating, the cross-section configuration of a terminal electrode is curving to convex. Therefore, if the bump who prepared the convex or flat apical surface of a semiconductor device is connected to a terminal electrode through a junction layer, it will become small [electrical installation resistance] most [between the peak of the curve side of a terminal electrode and a bump's points]. Therefore, when a gap arises at the time of alignment, the distance of a terminal electrode separates with a bump and connection resistance increases. Moreover, a connection also becomes unstable.
[0021] The place which it is made in order that this invention may solve the above-mentioned technical problem, and is made into the purpose The capillary for wirebonding equipments which makes it possible for reliability to be good and to connect a semiconductor device and the circuit board stably electrically easily, It is in offering the semiconductor unit (mounting object) which has the formation method of the bump and bump who have a curve side for connecting electrically the terminal electrode of the circuit board and the electrode pad of a semiconductor chip using it, and its bump.
[0022]
[Means for Solving the Problem] The formation method of the bump by this invention is the method of forming the bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board, and is characterized by to include the process a which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device, and the process b which forms a curve side in the aforementioned bump's point.
[0023] The circuit board to which the semiconductor unit by this invention has a terminal electrode on a front face, It is the semiconductor unit which has the semiconductor device mounted in the state of the face down on the front face of the aforementioned circuit board. the aforementioned semiconductor device It is characterized by having a bump for connecting electrically an electrode pad, the aforementioned electrode pad, and the aforementioned terminal electrode, forming a curve side in the aforementioned bump's point, and forming the junction layer between the aforementioned bump's point, and the aforementioned terminal electrode.
[0024]
[Function] In order that a bump's curve side may connect with the curved surface of a terminal electrode by forming a concave-like curve side in a bump's point in a field, the connection distance of a bump and a terminal electrode will be

shortened and the electric flow of this invention improves. Moreover, since bulk is formed stably, a bond strength is reinforced and reliability improves extremely.

[0025]

[Example] Below, each example of this invention is explained based on a drawing.

[0026] (Example 1) Drawing 1 (a) is the outline cross section of the point of the capillary tube for wirebonding in the 1st example of this invention. Drawing 1 (b) shows the configuration of the point of a capillary tube more to the detail.

[0027] leveling with which the capillary tube 1 of a cylindrical shape was formed in the periphery section of the point as shown in drawing 1 (a) -- it has the lobe 3 which is a member The capillary tube 1 is made with the ceramic or the artificial ruby. The soffit side (leveling side) 15 of a lobe 3 has a convex type-like curve side, and it is established so that the height from the face 11 at the nose of cam of a capillary tube 1 may be the predetermined value d. The size of the soffit side 15 can be set up according to the size of a bonding pitch and a bump's diameter of a nose of cam which should be fabricated. Moreover, in consideration of the configuration and size of a metal wire (or bump) after the interval which carries out bonding of the outside of the point of a capillary tube 1, and bonding, the angle alpha of about 10-30 degrees is given.

[0028] As shown in drawing 1 (b), when using the metal wire about 25 micrometerphi, the configurations of the point of a capillary tube are diameter:of hole38micrometer, diameter:of chip203micrometer, and diameter:of chamfer74micrometer.

[0029] Drawing 2 is the front view of the bump of the semiconductor device in the 1st example of this invention, and this shows one of two or more electrical installation points that it can set to some semiconductor devices. As shown in drawing 2 , the salient electrode (henceforth a bump) 27 is formed on the semiconductor device (henceforth IC substrate) 6. The concave-like curve side 24 is established in this bump's 27 point. In this example, the bump 27 has 2nd bump 27' smaller than it on the 1st bump 27, as shown in drawing 2 , and she is doing the configuration of the letter of a salient which became two steps (only henceforth a bump 27).

[0030] Drawing 3 (a) - (f) shows the outline of the method of using a capillary tube 1 and forming a two-step bump on the electrode pad 13 formed after the IC chip 6, by the ball bonding method in the 1st example of this invention.

[0031] it is shown in drawing 3 (a) -- as -- wire derivation of a capillary tube 1 -- it lets the metal wire 4 of 25 micrometerphi pass to a hole 2 And the ball 5 which has an about 2 to 3 times as many diameter as the path of the metal wire 4 is formed at the nose of cam of the metal wire 4 by giving heat energy.

[0032] Next, the ball 5 formed at the nose of cam of the metal wire 4 is made to contact the electrode pad 13 of the IC chip 6 by dropping a capillary tube 1, as shown in drawing 3 (b). By giving the method and supersonic oscillation of thermocompression bonding, the electrode pad 13 is made to fix a ball 5, and a two-step bump's pars basilaris ossis occipitalis 9 is formed.

[0033] and it is shown in drawing 3 (c) -- as -- a two-step bump's pars basilaris ossis occipitalis 9, and wire derivation of a capillary tube 1 -- while it has been in the state with which the metal wire 4 which the hole 2 let pass was connected, a capillary tube 1 is moved in the shape of a loop to the IC chip 6 After going up first at right angles to a two-step bump's pars-basilaris-ossis-occipitalis 9 upper part, a capillary tube 1 moves so that a loop-like orbit may be drawn.

[0034] As shown in drawing 3 (d), when a capillary tube 1 exercises in the shape of a loop to the IC chip 6, on a pars basilaris ossis occipitalis 9, the metal wire 4 is formed the shape of a ring, and inverted-L-shaped.

[0035] Then, a capillary tube 1 is moved so that the edge portion 12 of a capillary tube 1 may be located in the periphery of a two-step bump's pars basilaris ossis occipitalis 9, and the edge portion 12 cuts the metal wire 4, descending perpendicularly. A capillary tube 1 continues descent as it is, and carries out the press plastic surgery of the two-step bump according to the soffit side 15 for a lobe 3 established in the periphery section of a capillary tube 1. At this time, a capillary tube 1 descends until the face 11 contacts the electrode pad 13 (refer to drawing 3 (e)).

[0036] Moreover, as shown in drawing 3 (f), when it sees from a transverse plane, the soffit side 15 of a capillary may be made as the curve side is formed, and the direction in which a curve side is formed is not asked.

[0037] next, a part of semiconductor unit to which drawing 4 mounted the semiconductor device in the 1st example of this invention on the circuit board -- it is a cross section As shown in drawing 4 , the electroconductive glue 25 as a junction layer is applied to the curve side 24 of the point of the bump of the semiconductor device (IC substrate) 6 obtained at the above-mentioned process by the replica method or print processes. In this example, by using the bump of the letter of a two-step salient, it can prevent the electroconductive glue 25 more than an initial complement adhering to a bump point, and the electroconductive glue 25 of optimum dose can be applied. However, if the bump has the curve side 24 in the point, especially the configuration will not be restricted.

[0038] By this, thickness of a junction layer is made with the thinnest uniform thing, and connection resistance of a connection is low and can realize reliable electrical installation and reliable adhesion.

[0039] (Example 2) Drawing 5 (a) - (c) shows the outline of the method of forming the concave-like curve side 24 in a bump's point formed on the electrode pad 13 on the IC chip 6 in the 2nd example of this invention at a point using a ** implement with the convex type-like curve side 41.

[0040] Drawing 5 (a) is the two-step bump formed on the electrode pad 13 on the IC chip 6. The concave-like curve side 24 is formed in a bump's point by pressing this bump's point using a ** implement with the convex type-like curve side 41. At this time, as shown in drawing 5 (b) and (c), the direction in which a curve side is formed is not asked.

[0041] Even if it uses this formation method, the semiconductor unit shown in drawing 4 is obtained.

(Example 3) the cross section (a) of the semiconductor device which has a concave-like curve side in a bump's point in the 3rd

example of this invention when drawing 6 uses a solder plating bump, and a part of semiconductor unit which mounted the semiconductor device on the circuit board -- it is a cross section (b)
[0042] (Example 4) the cross section (a) of the semiconductor device which has a concave-like curve side in a bump's point in the 4th example of this invention when drawing 7 uses the bump of the letter of an one-step salient, and a part of semiconductor unit which mounted the semiconductor device on the circuit board -- it is a cross section (b)
[0043] (Example 5) a part of semiconductor unit which carried out the boundary of the anisotropy electric conduction material, and mounted the semiconductor device with which drawing 8 was obtained in the examples 1 and 2 on the circuit board -- it is a cross section
[0044] (Example 6) a part of semiconductor unit which drawing 9 carried out the boundary of the anisotropy electric conduction material which had the thickness more than the gap of a semiconductor device and the circuit board for the semiconductor device obtained in the examples 1 and 2, and was mounted on the circuit board -- it is a cross section
[0045]
[Effect of the Invention] Since a curve side can be easily formed in a bump's point formed using the usual ball bonding method, usual plating, etc. according to this invention, without being restricted to a special bump's structure and manufacture method as explained above, versatility is very high on practical use.
[0046] Furthermore, by this invention, by forming a curve side in the point of the bump of a semiconductor device, the junction distance between the interfaces of a bump and the terminal electrode on the circuit board can be shortened, and electric conductivity can be raised. By this, a bond strength is increased, it is further more certain and reliable electrical installation can be obtained.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the semiconductor unit using the formation method of the bump and bump who have a curve side for connecting electrically the terminal electrode of the circuit board and the electrode pad of a semiconductor chip by using the capillary for wirebonding equipments, and it, and its bump.
[0002]
[Description of the Prior Art] The capillary tube for the conventional wirebonding equipments is indicated by a bonding handbook, a capillary-catalog, etc. of a microphone loss chair company.
[0003] Drawing 10 (a) shows the point of the capillary tube for wirebonding equipments, and drawing 10 (b) shows the configuration of the point of a capillary tube more to the detail.
[0004] the wire derivation for the capillary tube 81 of a cylindrical shape inserting the metal wire for bondings in the interior, as shown in drawing 10 (a) -- it has the hole 82 wire derivation -- the size of a hole 82 is 25 micrometers phi-50 micrometerphi grade In consideration of the configuration and size of a metal wire after the interval which carries out bonding, and bonding, the angle alpha of about 30 degrees is given to the outside of the point of a capillary tube 81.
[0005] The configuration of the point of the capillary tube 81 in the case of using the metal wire about 25 micrometerphi is shown in drawing 10 (b). In this case, diameter:[of a hole]38micrometer, diameter:[of a chip]203micrometer, and the diameter of a chamfer: It is 74 micrometers. By using such a capillary tube 81, a bump can be formed on the electrode pad of a semiconductor device, or electric connection with the terminal electrode of other circuit boards can be made.
[0006] Next, the conventional method of forming the bump of a semiconductor device by the ball bonding method is explained using the capillary tube for wirebonding. The formation method of the electrical installation bump (henceforth a two-step bump) of a two-step projection configuration and the two-step bump using the conventional capillary tube is shown in JP,2-34949,A.
[0007] Drawing 11 (a) - (d) shows how to form a two-step bump by the conventional ball bonding method.
[0008] it is shown in drawing 11 (a) -- as -- wire derivation of a capillary tube 81 -- it lets the metal wire 84 of 25 micrometerphi pass to a hole 82 And the ball 85 which has an about 2 to 3 times as many diameter as the path of the metal wire 84 is formed at the nose of cam of the metal wire 84 by giving heat energy.
[0009] Next, the ball 85 formed at the nose of cam of the metal wire 84 is made to contact the electrode pad 183 of the IC chip 86 by dropping a capillary tube 81, as shown in drawing 11 (b). By giving the method and supersonic oscillation of thermocompression bonding, the electrode pad 183 is made to fix a ball 85, and a two-step bump's bottom 89 is formed.
[0010] and it is shown in drawing 11 (c) -- as -- a two-step bump's bottom 89, and wire derivation of a capillary tube 81 -- while it has been in the state with which the metal wire 84 which the hole 82 let pass was connected, a capillary tube 81 is moved in the shape of a loop to the IC chip 86 A capillary tube 81 cuts the metal wire 84, moving so that a loop-like orbit may be drawn and descending perpendicularly after that, after going up first at right angles to a two-step bump's bottom 89 upper part.
[0011] As shown in drawing 11 (d), on a bottom 89, the metal wire 84 is formed of movement of the shape of a loop of a capillary tube 81 the shape of a ring, and inverted-L-shaped. This portion forms a two-step bump's crowning 88. A two-step bump is formed by cutting the metal wire 84 by the edge portion 182 of a capillary tube 81.
[0012] The outline cross section of that (height was arranged) which leveled this two-step bump is shown in drawing 12 .
[0013] And the conventional example of the mounting method is described below. In case a semiconductor device is conventionally mounted in the input/output terminal electrode of the circuit board, the wirebonding method which used soldering is used well. However, by the miniaturization of the package of a semiconductor device, and the increase in the number of end-connection children, an end-connection child's interval becomes narrow and it is becoming difficult gradually to cope with it with the conventional soldering technology in recent years.
[0014] Then, recently, the method of a component-side product being miniaturized and aiming at efficient use has been proposed by mounting semiconductor devices, such as an integrated circuit chip, directly on the input/output terminal electrode of the circuit board.
[0015] Especially, suppose at the circuit board that it is a semiconductor device a method with the method useful from that electrical installation of a semiconductor device and the circuit board is made collectively, and the mechanical strength after